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REVIEW ARTICLE

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HASSLE FREE POWER MANAGEMENT SYSTEM FOR MOBILE BTS

CHENNATT PADMANABHAN SUPARNA
Malabar Institute of Technology, Anjarakkandy, Kannur, Kerala
India

CHENNATT PADMANABHAN SUPARNA

ABSTRACT

Hassle free power management system for mobile BTS introduces a power optimizing system for base transceiver station. This technique helps to maintain an uninterruptible communication service to the mobile users. The smart intelligent system monitors the battery under voltage levels, diesel engine alternator diesel tank float level and room temperature condition etc. Power optimization system is microcontroller based system which also has the GSM modem. This system avoids the manual control. Here the administrator at a far off place can monitor the current situations at the BTS. It can also be implemented in different places by doing some modifications.

I. INTRODUCTION

Base Transceiver Station (BTS) is the part of radio, which forms the electromagnetic wave in cell mobile communication. The length and breadth of the cell is size determined by the antenna transmitted power which leads the coverage area of the communication. An addition of uninterruptible power supply provides an uninterrupted operation of BTS equipment and hence the communication among the cell region and the hand off calls from other BTS Cells smoothed. The uninterruptible power supply system consists of an on line UPS. Engine alternator will continue the operations, if mains failure occur and thus a second confirmation is assured to avoid power supply to BTS. Recent studies on GSM operators showed that if the BTS outage is high [3], then about 8% of the total revenue will be lost. The situation becomes more acute while deferent operators sharing the same BTS tower for fixing their different channel frequency antenna and hence the same power system is used for different frequency GSM/CDMA [4] operators.

Prolonged main power failures in villages are usual practices than the urban area, which leads to the requirement of fault proof monitoring and control systems. BTS Power Optimization System is an attempt to settle the issue permanently. This smart intelligent system monitor the battery under voltage levels, Diesel Engine alternator diesel tank float level, line voltage and room temperature condition etc. When mains fails, after a prefixed time, the system itself switch on an engine alternator and constantly monitor the float level of the diesel tank. Infrared float sensors are used for this purpose. This helps to keep the diesel tank with adequate fuel level always. Battery life will be affected badly when the BTS System mains fails due to over discharge of battery and it can be also avoided by constantly monitoring the voltage levels by comparing with threshold level. It is also important that maintaining the room temperature at specific level to keep BTS equipment operation at optimum level. Ultimately the system itself efficiently monitors power conditioning and control of the BTS equipments to avoid the total outage of communication system. This adaptive technique helps to maintain an uninterruptible communication service to the mobile users. It also helps the top level management staffs to monitor the maintenance efficiency of the supervisory staffs. The system is developed in a generic way so that it can further implement in any industrial area after doing little modification.

II. PRINCIPLES OF CELL SITES

Power management of cell sites protects your network, tracks and measures cell site performance for peak operation, identifies performance problems with Speed and Precision and enables efficient. On demand Intervention in Site failures or breakdowns, since the best problems are those successfully avoided. Our paper has introduced the Power management of which enables the wireless operators to monitor cell sites remotely for performance degradation before it affects network integrity. Our paper mainly works on: 1. Controls multiple individual subsystems per base station site and thousands or more base station sites across network. 2. Alerts users immediately when smoke and fire alarms are triggered to prevent or reduce damage to cell sites 3.Reduces energy consumption through automatic maintenance and monitoring of temperature and humidity. 4. Deters theft and vandalism by monitoring and controlling remote cameras, motion detection alarms, and door sensors. 5. Dramatically reduces site visits and turns your entire network a deeper shade of green. High efficiency rectifier modules convert the mains AC to a 48V DC voltage for the radio equipment. High efficiency technology reduces losses of the AC/DC and DC/DC power conversion to a minimum and also contributes to the reduction of the requested air conditioning power. Free cooling air conditioning systems reduces the energy consumption of the base station additionally, in comparison to traditional solutions and have to be designed in a way which allows easy disassembling and component separation for recycling.

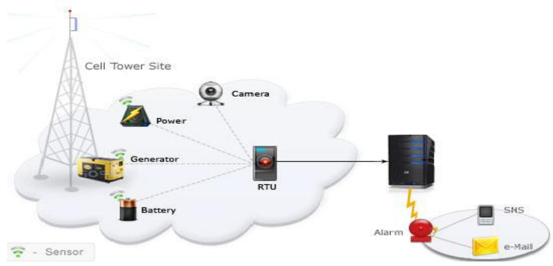

Fig.1 Over view of power management of cell site

III. BASIC BUILDING BLOCKS OF THE SYSTEM

The power supply system of the Cell site BTS consists of various elements which all have to contribute to energy savings and reduction of C02 emissions.

A. *High Efficiency Rectifier*

Modern High Efficiency rectifier technology can contribute to energy savings in various ways. Compared to traditional rectifier technology with a maximum efficiency of approximately 92%, high efficiency products convert AC to DC power with an efficiency of more than 95% over a wide load range and even above 96% under optimum load conditions. This means a reduction of electrical energy losses to half of the value compared to traditional switch mode rectifier technology. Half the electrical losses also mean half of waste heat dissipation from the rectifier's power conversion. Therefore it is also possible to reduce the size of air conditioning equipment and to save a significant amount of the energy which is needed to get rid of the heat losses from the equipment, compared to a traditional BTS. If smart modern air conditioning is combined with High Efficiency rectifier technology, energy savings will pay back the higher investment costs compared to traditional systems in short time usually within less than 2 years.

B. *Battery Backup*

Batteries are a part of the BTS concept. They are needed to make the power feeding of the telecom load uninterruptable, if a mains failure occurs the load completely or are still in standby mode and need time to start up as it might happen with a backup battery. The battery can be automatically switched on by sending an SMS battery ON. When the battery is going to completely discharge, the sensor technology will again send the percentage of power remaining in the back up battery to the operator through GSM technology. Once by knowing the charging of the battery, the operator will decide whether to switch on the diesel generator or not. As once the power is gone the back battery can be automatically switched on, but by using the GSM technology the operation can decide whether to switch on the diesel generator or the battery. Depending on the time constraint there is necessity of switching on the diesel generator, as the backup battery cannot supply the sufficient power to the cell sites for a long time. Backup batteries are sensitive to extreme temperatures and their lifetime depends a lot on their operational temperature, number of charge and discharge cycles and they require some maintenance during their lifecycle. This has to be considered in the planning phase of the BTS and will have an influence on the decision of the air conditioning system.

C. Solar Power

The idea of the BTS includes the utilization of alternative and renewable energy sources. Depending on the region where the BTS is installed, solar power can provide an important contribution for the power supply. Especially in southern regions with high numbers of sunshine hours, this is an interesting option. The highest power demand in a typical BTS is based on 48Vdc voltage. Therefore it is beneficial to use DC/DC converters that can directly convert the unregulated DC output voltage and current from a solar panel to a regulated output voltage for the BTS equipment. A smart regulation and control unit is required, to allow a direct parallel power feed from solar converters and other rectifier or DC/DC converter technology on the same power bus. As long as there is solar energy available, the solar converters contribute to the BTS feed and if possible even charge the battery. But there are some disadvantages to be considered. Solar converters can deliver power only during sunshine hours. During the night or on cloudy days, other energy sources have to cover the power demand of the BTS. Large solar panels are expensive and take up considerable space. That is the reason why solar energy is only useful for applications with low DC power demand with less than 2kW. There has to be enough space for the solar panel and no item around which might cause shadow or pollution. Depending on the region, snow could also become an issue. Besides the technical restrictions it is also important to protect solar panels from theft in unmanned locations. In summary it can be said, that solar power is a good add on to save mains energy but solar power is an unreliable source for BTS applications in cell sites.

D. Inverter and Static Switch

Some equipment in the BTS may depend on uninterrupted AC power. Therefore a highly efficient inverter is needed which converts the DC voltage from the load and battery to the requested AC voltage. A typical AC consumer in a BTS is the active air conditioning system, which only works under extreme temperature conditions. Some 3G radio equipment also has direct AC feed and depends on inverters as well. One target for BTS should be to avoid consumers that depend on AC power. This would allow one to design systems which just use DC and avoid the additional conversion step from DC to AC including its losses. As long as the most air-conditioning systems use some AC power, inverters will still be in place. If there is a public mains supply available, AC loads are usually directly fed from the mains to reduce conversion losses. A static switch unit monitors the mains voltage and if the mains power fails, the AC loads will be connected to the output of the inverter modules. This offline mode reduces losses which are generated from the DC to AC conversion process in the inverter. In off-grid BTS sites there is no static switch. In BTS sites with mains supply, the inverter serves as a redundant AC source to the public mains. The AC load has to be considered when the backup time and energy consumption during a mains outage period is calculated.

E. Transceiver Equipment

The control unit of the power system is the brain of a complex control, regulation and communication system. On the one hand it has to control and communicate with the power system building blocks as there are rectifiers, converters. On the other hand the system control unit has to communicate with a remote NMS (Network Management System) for alarm management, remote monitoring and remote control. For the internal communication, digital bus systems or small networks are used (e.g. CAN). For the remote interface, wireless GSM modems or network solutions are the most common communication units. Besides the control functions, alarm memory capabilities are of high importance. The complete control, monitoring, regulation and interaction between the different power blocks have to be managed from this control unit. But the control unit may not become a single point of failure which can cause the whole system to collapse if it fails. So there must be a strategy and emergency function in all active power building blocks, to guarantee an emergency mode, which provides power to the connected equipment. A video surveillance is also provided in the BTS room, to view the room and get the instantaneous information. The remote interface, wireless GSM modems are mainly operated by either controllers or processor. When the power is off then the operator will receive a message from the control unit. Then the operator can switch on the diesel generator by sending the commands. The sensors that are kept in the BTS room will report the temperature in the room, so that the operator can switch on the air conditioning unit in the BTS room.

F. Air conditioning system

The decision for the air-conditioning system has a very important influence on the power demand of the BTS. Free cooling of the BTS during the major part of the year saves a lot of energy compared to traditional air con equipment. Unfortunately this is the most expensive solution according to invest costs, but may gain back the money with reduced energy costs within only a few years of operation, depending on the given conditions. Target is to use the fee cooling mode as much as possible and to reduce the active air conditioning time to the very lowest limit. This requires that the installed equipment needs to have a wide range of operating temperature. The smaller the operating temperature range of the equipment, the more often active regulation and active air conditioning is required. Depending on the temperature and power profile of the location, power savings of approximately 80% are possible compared to traditional air conditioning solutions. In many cases it is not possible, just to work with fee cooling systems. This means that for periods of extreme temperature, active heating or cooling is required. For this reason we can find a combination of fee cooling and active air conditioning in the most cases. So it is a challenge for all component and equipment manufacturers to design their products for a wide temperature range. If this is fulfilled, fee cooling can give all benefits and possible energy savings. Additionally, modem air conditioning systems are noise reduced compared to older models, which is also a contribution to the environmentally friendly.

G. Transceiver Equipment

The most important equipment form the view of the Telecom Operators is of course the transceiver equipment, which is the main load of the described power equipment. The transceiver equipment can also contribute to the BTS. Highly efficient equipment is an important base for energy savings and to reduce the size and power consumption of the air conditioning system. High integration density and smart solutions help to reduce the size of the transceiver equipment, and with that the space demands for such transceiver stations. Modern BTS can be much smaller than those that we know from earlier years. Transceivers for Microcells are so small that they can be installed almost everywhere with very little optical impact on the environment. Modern transceiver equipment has a wide operating temperature range which allows the installation in rooms without temperature regulation, as long as extreme temperatures can be avoided. Air conditioning systems can be designed much more efficiently and just need to be active for short periods. Reduced size and weight of the transceiver equipment reduces packaging and freight logistic resources which contributes to environmental care as well.

IV. BLOCK DIAGRAM

BTS monitoring systems provide solutions for telecoms operators and service providers. Most monitoring applications check quality of service and detect nearly 100% of mobile service errors or glitches. It is usually is not limited to Quality of Service (QoS) monitoring. It also includes monitoring passive infrastructure such as ultrasonic fuel levels, battery cells, power metering, physical security of a cell site, and other environmental parameters such as temperature, humidity or any kind of leaks. The proposed Power Management Controller is capable of providing current, voltage, power and temperature calculations with maximum error. All telecommunications are dependant of reliable power supply systems. This paper develops low cost, real time system which can monitor and control the operation of cell sites. The described control and maintenance system will be an important tool to create a better total availability for the power feeding of different telecommunication systems..

The BTS Power Optimization System consists of a controller and one or more switching and monitoring units. This smart intelligent system monitor the battery under voltage levels, Diesel Engine alternator diesel tank float level and room temperature condition etc. When mains fail happened; after a prefixed time the system itself switch on an engine alternator and constantly monitor the float level of diesel tank. When the float level comes down below the reserve point, system itself generates an SMS to the authentic Supervisor informing to top up the diesel tank. Electronic or capacitive float sensors can be used for this purpose. This helps to keep the diesel tank with adequate fuel level always. When the BTS System drain current from battery continuously on mains failure, over discharge of battery may happen this will badly affect the battery life. This is also avoided by constantly monitoring the voltage levels by comparing with threshold level and in a default case the system itself automatically generates SMS to the supervisor to take care of power systems to avoid total outage of BTS. Maintaining of the room temperature to a required level is an important thing to keep BTS equipment operation optimum level. The system continuously monitor room temperature and control switching of AC plant to keep the temp level between the upper and lower set level. In any case the room temperature exceeds the set level, immediately system generates SMS to the supervisor, so that he can take measures to avoid of system failure.

A. Mobile Station

This is the mobile handset unit used to send and receive the command data to and from the BTS optimization unit which contain GSM Modem as the wireless communication link. The commands are send to the GSM modem in the form of encrypted SMS message .This unit is helpful for monitoring the different parameters of the system and switching conditions.

B. Oscillator

The micro controller has to be provided with a clock signal for its timing and control signals. Only an external crystal is sufficient for an oscillator with the internal phase shift amplifier. An 12MHz crystal is selected which provides an internal cycle timing which is 1/12 of the oscillator frequency.

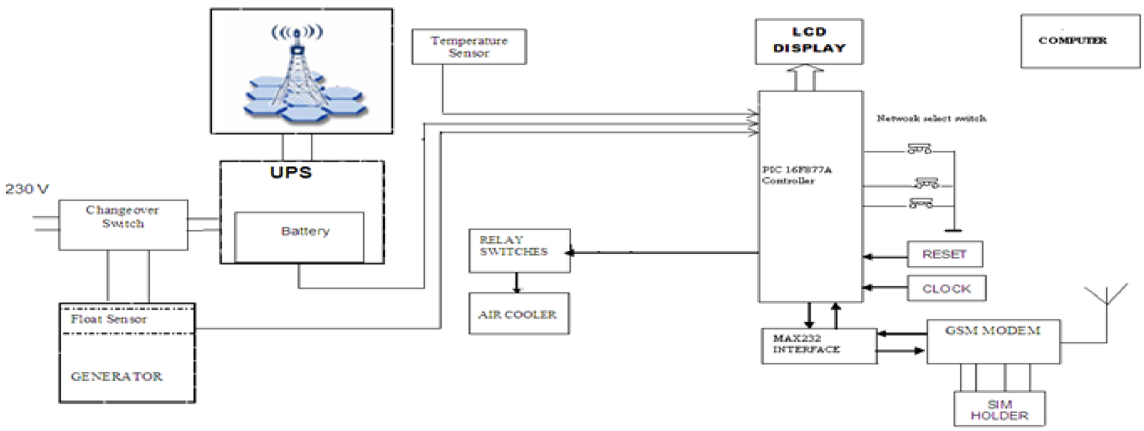

Fig.2. Block diagram for hassle free power management system for mobile BTS

C. Micro Controller

BTS Power Optimization System is based on the This powerful (200 nanosecond instruction execution) yet easy to program (only 35 single word instructions) CMOS FLASH based 8-bit microcontroller packs Microchip's powerful PIC architecture into an 40- or 44-pin package and is upwards compatible with the PIC16C5X, PIC12CXXX and PIC16C7X devices. The PIC16F877A features 256 bytes of EEPROM data memory, self programming, an ICD, 2 Comparators, 8 channels of 10-bit Analogue-to-Digital (A/D) converter, 2 capture/compare/PWM functions, the synchronous serial port can be configured as either 3-wire Serial Peripheral Interface (SPI) or the 2-wire Inter-Integrated Circuit (I^2C) bus and a Universal Asynchronous Receiver Transmitter (USART). All of these features make it ideal for more advanced level A/D applications in automotive, industrial, appliances and consumer applications.

D. Reset Circuit

Reset of the micro controller chip is accomplished by holding the RESET pin high for at least two machine cycles (24 oscillator periods) while oscillator is running. The CPU responds by executing an internal reset. The internal reset is executed during the second cycle in which RESET is high and is repeated every cycle until RESET goes low.

E. Temperature Sensor

The temperature measurement is carried out by the integrated semiconductor temperature sensor LM35. The LM35 series are precision integrated-circuit temperature sensors, whose output voltage is linearly proportional to the Celsius (Centigrade) temperature.. The LM35 does not require any external calibration or trimming to provide typical accuracies of ± ¼ °C at room temperature. It can be used with single power supplies, or with plus and minus supplies. The LM35 is rated to operate over a -55°C to +150°C temperature range.

F. MAX232 Interface

The central computer is communicating to the control unit through the serial or RS232 interface which is connected to a RF transceiver. The RS232 signal is ± 9-15V bipolar signals. These signal levels are translated to logic levels and vice versa by the RS232 interface circuits. MAX232 is RS232 interface, which converts the ± 9V bipolar signal into digital logic levels and converts the logic level signal to ± 9V bipolar signal levels. MAX232 requires only +5V supply voltage to convert the signal levels. Each IC has four buffer gates, but only a single buffer is used from each one of them. The serial data from/to the serial port is interfaced to the RF transceiver through a 40 pin piccontroller PIC16F877A.The PIC16F877A has 8K bytes of Flash internal program memory, 368bytes of RAM, 5 I/O ports. With few discrete components for oscillator and reset, a complete micro controller system can be implemented. The PIC16F877A controller configures and controls the RF transceiver for RF transmission and reception.

G. Fuel Level Sensor

Infrared Proximity Sensor Long Range - Sharp GP2Y0A02YK0F made by Sharp. GP2Y0A02YK0F has an analogue output that varies from 2.8V at 15cm to 0.4V at 150cm with a supply voltage between 4.5 and 5.5VDC. The sensor has a Japanese Solder less Terminal (JST) Connector. We recommend purchasing the related pigtail below or soldering wires directly to the back of the module.

H. Relay Driver

The switching relays are activated by the micro-controller output lines using driver circuits. The micro-controller output lines have limited current drive capacity, so that driver stages are required for increasing the drive currents. Drive circuits provide sufficient drive signal for the output devices.

V. HYBRID SYSTEM WITH MAINS POWER

The BTS has mains supply via rectifiers, solar-power, battery, inverter, fee cooling and active air conditioning. Various operation modes are possible.

A. Mode 1: Mains On, Load < Power

In Mode 1 there is more power available from solar than the load demands. This is the ideal case to save mains energy. The control unit is responsible for power management which keeps the mains rectifiers in a standby mode and DC power is only provided from the solar converters. The backup battery is in a standby-mode, always prepared to start within about 15 seconds. AC consumers are directly fed from the mains. In this mode all DC power is generated from alterative sources. If the DC power of the solar and wind converters drops below the load request, the backup battery supports the load feed. If the battery is discharged to a certain level, mains rectifiers are started and support the power feed of the loads.

B. *Mode 2: Mains On, Load> Power*

In Mode 2 there is more power demand from the loads than available power from solar energy. In this case the mains rectifiers work in parallel with the power sources on the same DC power bus, sharing the load in such a way that as much energy is used as possible. If there is no solar energy available at all, the mains rectifiers deliver the full DC power and recharge the battery, if this is necessary. AC consumers are fed directly via the static switch from the mains. As soon as there is more energy available than load demanded, the rectifiers go back into a standby mode and Mode I is active again.

C. *Mode 3: Mains Off, Load < Power*

In Mode 3 mains power is not available but solar energy is sufficient to feed the BTS. The AC consumers are fed from the inverter. As soon as the mains power is back, the system is switched to Mode I immediately.

D. *Mode 4: Mains Off, Load> Power*

In Mode 4 mains power is not available and solar energy is not sufficient to feed the loads. This is the time to start the battery. The battery output is connected to the same DC power bus as the solar converters. Now all regenerative power sources are working in parallel, managed by the central control unit and share the load with their capabilities. Priority is to use as much energy from sun as possible, and to reduce hydrogen consumption to a minimum. As soon as mains is available again, the battery will return into the standby mode and the system will return into Mode 2.

E. *Mode 5: Emergency Mode*

If there is a critical problem with the central control unit, the system has to be switched to the Emergency Mode. In this mode, an alarm will be set off and rectifiers and DC/DC converters will operate in a default setting. The output voltage of the rectifiers is set a little bit above the voltage of the solar converters. So the rectifiers will take the load as long as there is mains power available. If mains power fails as well during this condition, solar converters can take the load. If the load is too high and the battery gets discharged to a certain value, automatically and contribute to the power. The power management is no more optimised to save hydrogen resources, but the system will still feed the load. Therefore it is a failsafe mode for the uninterruptable power.

VI. PCB DESIGN

The Printed Circuit Board (PCB) provides the electrical interconnections between various components and as well provides mechanical support to the components. The components are soldered to the PCB. The quality of the soldering directly affects the reliability of the circuit. The procedure for fabricating the PCB for any general project is described below.

A. *PCB Making*

Making of PCBs is as much as an art as a technique. The making of PCB essentially involves two steps:

- Preparing the PCB drawing
- Fabricating the PCB itself from the drawing.

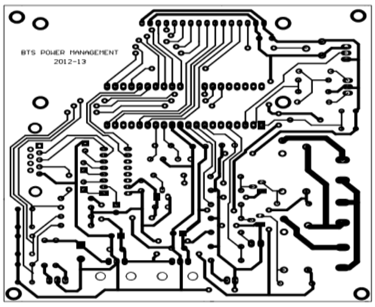

Fig.3 PCB Layout

1) *PCB Drawing*: Making of PCB drawing involves some preliminary considerations such as placement of components, locating holes, deciding the diameters of various holes, the optimum area that each component should occupy, the shape and size of pads for the components, track size and spacing, full space utilization and prevention of overcrowding of components at a particular area etc. There is no other way to arrive the conclusion than by trial and

error. With these details the sketch of the PCB is made.

2) *PCB Fabrication:* The fabrication of the PCB starts with transferring the PCB drawing onto a copper clad sheet. For small number of PCBs, a direct photographic transfer of the PCB drawing from a negative image of the drawing to a photo sensitized copper clad sheet is carried out. The copper from the unexposed area is latter etched away. For large quantity production, screen printing method is used to transfer the PCB drawing image to the copper clad sheet. For etching the copper clad sheet, 20-30 gms of Ferric chloride in 75ml of water heated to about 60°C may be used. The copper clad sheet is placed in this solution with its copper side upwards in a plastic tray. Stirring the solution helps speedy etching. The dissolution of unwanted copper would take about 45 minutes. If etching takes longer, the solution may be heated again and process is repeated. The paint on the pattern can be removed by rubbing with a rag soaked in thinner, turpentine or acetone. The PCB then be washed and dried. The pads are drilled with proper drill sizes of 0.9mm, 1.0mm, 3mm etc. for the leads and mounting holes. Need to generate a positive UV translucent artwork film. You will never get a good board without good artwork, so it is important to get the best possible quality at this stage. The most important thing is to get a clear sharp image with a very solid opaque black. Nowadays, artwork is drawn using either a dedicated PCB CAD program or a suitable drawing graphics package. It is absolutely essential that your PCB software prints holes in the middle of pads, which will act as centre marks when drilling. It is virtually impossible to accurately hand drill boards without these holes. If you're looking to buy PCB software at any cost level and want to do hand prototyping of boards before production, check that this facility is available. If a general-purpose CAD or graphics package, define pads is used as either a grouped object containing a black filled circle with a smaller concentric white filled circle on top of it, or as an unfilled circle with a thick black line. When defining pad and line shapes, the minimum size recommended for vias for reliable results is 50 mil, assuming 0.8mm drill size 1 mil = (1/1000)th of an inch. You can go smaller with smaller drill sizes, but through-linking will be harder. Centre-to-centre spacing of 12.5mil tracks should be 25 mil slightly less may be possible if your printer can manage it. Take care to preserve the correct diagonal track spacing on metered corners; grid is 25 mil and track width 12.5 mil. The artwork must be printed such that the printed side is in contact with the PCB surface when exposing, to avoid blurred edges. In practice, this means that if you design the board as seen from the component side, the bottom layer should be printed the 'correct' way round, and the top side of a double-sided board must be printed mirrored.

VII. CONCLUSIONS

All telecommunications are dependant of reliable power supply systems. This paper develops low cost, real time system which can monitor and control the operation of cell sites. The described control and maintenance system is an important tool in our efforts to create a better total availability for the power feeding of our different telecommunication systems. Implementing the system into service has enabled the creation of the open platform for the whole infrastructure integration in one monitoring system. With this background, we developed a low cost, real time system which helps to monitor and control the operation of cell sites.

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AUTHOR BIOGRAPHY

Chennatt Padmanabhan Suparna , received Diploma in Electronics from Govt. polytechnic college Trikkaripur in 2010, B tech in Electronics and Communication from Calicut University in 2013 and M tech in Digital Electronics from Kannur University.